

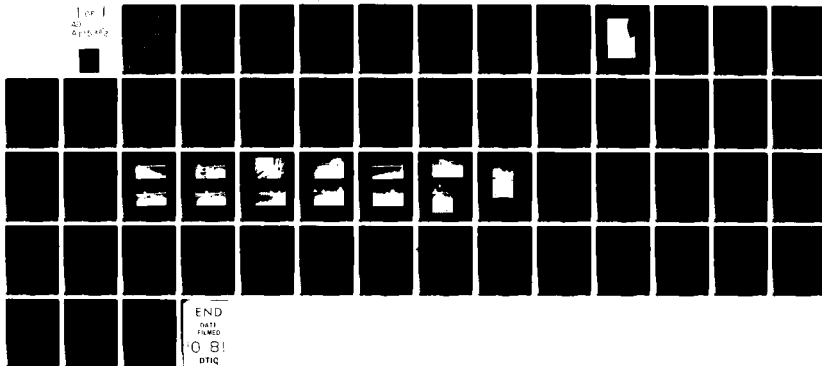
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CATES DAM

MONTGOMERY COUNTY, MISSOURI

MO. 10172

AP A 105353

**PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM.**

Cates Dam (MO 10172),
Mississippi - Kaskaskia - St. Louis Basin,
Montgomery County, Missouri. Phase I
Inspection Report.



**United States Army
Corps of Engineers**

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Serving the Nation*

St. Louis District

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10 Rey S./Decker Gordon /Jamison
Michael /McMeekin Harold P. /Hoskins

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

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CATES DAM
MONTGOMERY COUNTY, MISSOURI
MISSOURI INVENTORY NO. 10172

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

JUNE, 1979

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Cates Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Cates Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood.
- 2) Overtopping could result in dam failure.
- 3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY

SIGNED

Chief, Engineering Division

10 DEC 1979

Date

APPROVED:

SIGNED

Colonel, CE, District Engineer

10 DEC 1979

Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	Cates Dam
State Located	Missouri
County Located	Montgomery County
Stream	Smith Branch Offstream
Date of Inspection	June 27, 1979

Cates Dam was inspected by an interdisciplinary team of engineers, ~~from Hoskins-Western-Sonderregger, Inc.~~ The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately three miles downstream of the dam. Within the damage zone are three residences, outbuildings, two county roads and State Highway 161.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the recommended guidelines for a small dam having a high hazard potential. Considering the small amount of water impounded and the large floodplain downstream one-half of the Probable Maximum Flood is the appropriate spillway design flood. The spillways will not pass the 100-year flood (flood having a one percent chance of being exceeded in any year) nor one-half of the Probable Maximum Flood without overtopping the dam. The spillways will pass 13% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

Overtopping could result in failure of this dam and actions recommended in Section 7 of this report should be pursued on a high priority basis.

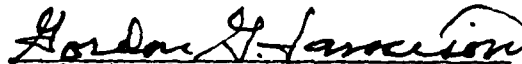
No design data were available for this dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These analyses should be obtained in the future and made a matter of record.

Other deficiencies observed during the inspection that should be corrected in the near future are: small trees growing along the water's edge and in the emergency spillway inlet and outlet sections and minor erosion on the upstream face of the dam.


Maintenance of this dam is good. Maintenance items detailed in the report are addressed to removal of trees and the future control of tree growth and embankment erosion.



Rey S. Decker
E-3703



Gordon Jamison



Michael McMeekin
E-4776



Harold P. Hoskins
Chairman of Board
Hoskins-Western-Sonderegger, Inc.
E-8696



PHOTO NO. 1 - OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
CATES DAM - MO 10172
MONTGOMERY COUNTY, MISSOURI

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Cates Dam be made.
- b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.
- c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report of the Chief of Engineers and the National Program of Inspection of Dams", dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

- a. Description of Dam and Appurtenances.
 - (1) The dam is a small earthfill located in the Central Clay Pan area of northeastern Missouri. Topography of the area is nearly flat to gently rolling.
 - (2) The uncontrolled principal spillway consists of a 10-inch diameter steel pipe with hooded inlet and antivortex flap on top.
 - (3) An uncontrolled vegetated earth spillway is cut through the right abutment of the dam.
 - (4) Pertinent physical data are given in paragraph 1.3 below.

- b. Location. The dam is located in the central portion of Montgomery County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in the NE $\frac{1}{4}$ of Section 16, T48N, R5W. The lake formed behind the dam is shown in the NE $\frac{1}{4}$ of Section 16, T48N, R5W.
- c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the small size category.
- d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph 1.1c above. Based on referenced guidelines, this dam is in the High Hazard Classification. The estimated damage zone extends approximately three miles downstream of the dam. Within the damage zone are three residences, outbuildings, two county roads and State Highway 161.
- e. Ownership. The dam is owned by Mrs. Ardine Cates, 3102 Hillview Drive, Bridgeton, Mo. 63044.
- f. Purpose of Dam. The dam was evidently constructed as an erosion control structure.
- g. Design and Construction History. It was reported by Mrs. Cates that the dam was constructed in 1968 or 1969. No other information was available on the design or construction of this dam.
- h. Normal Operating Procedure. All spillways are uncontrolled, and there are no operating procedures for this dam.

1.3 PERTINENT DATA

- a. Drainage Area. 77 acres (0.12 square miles).
- b. Discharge at Damsite.
 - (1) All discharges at the damsite are through a principal spillway consisting of a 10-inch diameter steel pipe spillway with a hooded inlet and a grassed earth channel ungated emergency spillway.
 - (2) Estimated maximum flood at damsite -- unknown.
 - (3) The principal spillway capacity varies from 0 cfs at elevation 832.2 feet to 8 cfs at the crest of the

emergency spillway (elevation 833.6 feet) to 8 cfs at the minimum top of dam (elevation 834.2 feet).

- (4) The emergency spillway capacity varies from 0 cfs at its crest elevation 833.6 feet to 19 cfs at elevation 834.2 feet (minimum top of dam).
- (5) Total spillway capacity at the minimum top of dam is 27 cfs \pm .

c. Elevations (feet above M.S.L.).

- (1) Top of dam - varies irregularly from 834.4 (minimum) to 836.4 (maximum)
- (2) Principal spillway crest - 832.2 \pm
- (3) Emergency spillway crest - 833.6 \pm
- (4) Streambed at centerline - 814 \pm
- (5) Maximum tailwater - unknown

d. Reservoir. Length (feet) of maximum pool - 1200 \pm .

e. Storage (Acre-feet).

- (1) Top of dam - 80 \pm
- (2) Principal spillway crest - 58 \pm

f. Reservoir Surface (Acres).

- (1) Top of dam - 13 \pm
- (2) Principal spillway crest - 9 \pm

g. Dam.

- (1) Type - Earthfill
- (2) Length - 980 feet \pm (measured)
- (3) Height - 22 feet maximum (measured)
- (4) Top width - 8 feet (measured)
- (5) Side slopes
 - (a) Downstream - 3H on 1V (measured)
 - (b) Upstream - Exposed = 6.7 to 7.5H on 1V (measured)
- (6) Zoning - unknown
- (7) Impervious core - unknown
- (8) Cutoff - unknown
- (9) Grout curtain - unknown
- (10) Wave protection - vegetated berm

h. Diversion Channel and Regulating Tunnel. None.

i. Spillway.

(1) Principal

- (a) Type - uncontrolled, 10-inch steel pipe with hooded inlet.
- (b) Crest (invert) elevation = 832.2 feet \pm .
Outlet = 813.9 feet \pm .
- (c) Length = 92 feet \pm .

(2) Emergency

- (a) Type - uncontrolled vegetated earth channel cut through right abutment, "U" shaped section with 38 feet \pm width across the top.
- (b) Control section - weir crest
- (c) Crest elevation - 833.6 feet \pm
- (d) Upstream channel - well vegetated on slope of 3.8% \pm
- (e) Downstream channel - well vegetated on slope = 3% \pm

j. Regulating Outlets. None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were available.

2.2 CONSTRUCTION

No construction data were available. It was reported by Mrs. Cates that the dam was constructed in 1968 or 1969.

2.3 OPERATION

It was reported by Mrs. Cates that the emergency spillway operated twice about 3 or 4 years ago.

2.4 EVALUATION

- a. Availability. No data were available.
- b. Adequacy. The field surveys and visual observations presented herein are considered adequate to support the conclusion of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.
- c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Cates Dam was made on June 27, 1979. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska, making the inspection were: R. S. Decker, Geotechnical; Gordon Jamison, Hydrology; and M. McMeekin, Civil Engineer. Mrs. Cates, the Owner, was not present during the inspection.

b. Dam.

- (1) Geology and Soils. This site is located in the Central Claypan physiographic area. Soils in the area are classified in the Mexico-Putnam group which are developed in 8 to 10 feet of slowly permeable, plastic loess (CL). The loess overlies fine grained plastic glacial till (CL or CH) with a paleosol at the interface of the two deposits. Materials in the embankment and abutments are plastic clay (CL or CH). Foundation materials exposed in the pipe spillway outlet are plastic clays (CL or CH) derived from the upland loess and/or the till on the gentle valley slopes.
- (2) Upstream Slope. The upstream slope is well vegetated with adapted grasses and reeds. A few small willows are growing along the water line. There appears to be a berm at or near the principal spillway elevation. The water surface was just below the berm elevation when inspected. A few small (1/8" wide x 2' long) drying cracks were noted in the berm on both sides of the principal spillway inlet. No deformation was noted on the upstream slope. Some very minor erosion was noted toward the west (right) end of the dam at the junction of the berm and upstream slope.
- (3) Crest. The crest is well vegetated with adapted grasses. A few small (1/8" wide x 2' long) cracks parallel with the axis of the dam were observed on both sides of the principal spillway. The cracks appear to be the result of desiccation. No rodent holes or deformations were noted on the crest. The crest and downstream slope had been recently mowed.

- (4) Downstream Slope. The downstream slope is very well vegetated with adapted grasses. No cracks, rodent holes or deformations were observed. There was no sign of seepage on the slope or along the toe of the dam.
- (5) Miscellaneous. The excellent vegetative cover and the apparent materials in the embankment indicate that this structure could withstand considerable overtopping without serious damage.

c. Appurtenant Structures.

- (1) The principal spillway consists of a 10-inch steel pipe with hooded inlet and antivortex device. No deterioration of the pipe was observed. The inlet was clear and open. The reservoir level was about 1 foot below the inlet of the spillway.
- (2) The emergency spillway is cut through CL-CH soils on the right abutment. It is very well vegetated and open. No erosion, slump, slides or deformations were observed in the spillway. The exit channel for the spillway parallels the downstream slope of the dam but discharges should not cause any serious damage to the dam.

A few small trees are growing in the inlet to the spillway.

- (3) Drawdown Facilities. The only operating facility for this dam consists of a 1-inch diameter iron pipe through the embankment to the right of the principal spillway. This line is connected to a hydrant on the downstream end. The hydrant is operable.

d. Reservoir Area. Some shoreline erosion was observed in the northeast corner and along the north shore of the reservoir. The erosion did not appear to be significant.

e. Downstream Channel. The outlet channel for the principal spillway is clogged with concrete rubble and trash. No slides or significant erosion was noted in the scour hole or outlet channel.

3.2 EVALUATION

This dam looks good and does not appear to have any serious potential of failure. The few small trees on the upstream slope, in the emergency spillway inlet and in the principal spillway outlet should be removed. Significant overtopping of the dam should not cause serious damage to the structure.

Minor erosion on the upstream slope toward the right end of the dam could ultimately impair the integrity of the structure and should be corrected.

Drying cracks observed on the upstream berm and crest of the dam should not affect the stability of the dam.

Obstructions in the outlet channel of the pipe spillway should not significantly affect the overall efficiency of spillway operation since pipe discharges are very small compared to total spillway discharges.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works for this dam. The pool level is controlled by rainfall, evaporation, and the capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

The dam and emergency spillway had been recently mowed. Maintenance, in general, seems to be good. The few trees on the dam and in the spillway channels should be removed.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team found no warning system in effect for this dam.

4.5 EVALUATION

There does not appear to be any serious potential of failure of this structure.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

- a. Design Data. No design data were found for this dam. All computations are based on field inspection and surveys by the consultant. The plan, profiles and cross sections from the survey are attached in Appendix C.
- b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS New Florence, Missouri 7 1/2 minute topographic quadrangle map. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection.
- c. Visual Observations.
 - (1) The principal spillway pipe appeared to be in good condition.
 - (2) The emergency spillway is located in the right abutment of the dam. A few small trees are located at the entrance of the spillway. Spillway releases flow along the downstream toe of the dam and into the old stream channel.
 - (3) The outlet channel of the spillway pipe is clogged with concrete rubble and debris.
 - (4) No drawdown facilities are available to evacuate the pool with the possible exception of the 1-inch pipe described in paragraph 3.1.c(3).
- d. Overtopping Potential. The spillways are too small to pass 50% of the probable maximum flood and the 100-year flood without overtopping. The spillways will pass 13% of the probable maximum flood without overtopping. In addition, the spillway will pass the 10-year storm. Materials in this dam and the excellent vegetative cover indicate that the dam could withstand significant overtopping without potential of failure. The results of the routings through the dam are tabulated in regards to the following conditions:

<u>Frequency</u>	<u>Inflow Discharge c.f.s.</u>	<u>Outflow Discharge c.f.s.</u>	<u>Maximum Pool Elevation</u>	<u>Freeboard Top of Dam Min. Elev. 834.2</u>	<u>Time Dam Overtopping Hr.</u>
10 Yr.	300	12	833.8	+ 0.4	0
100 Yr.	400	35	834.4	- 0.2	3 ±
1/2 PMF	700	600	835.1	- 0.9	6 +
PMF	1400	1300	835.4	- 1.2	10 ±
0.13 PMF	180	27	834.2	0	0

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard rating and a small size. Therefore, the 1/2 PMF to the PMF is the test for the adequacy of the dam and its spillway.

The estimated damage zone is described in Paragraph 1.2d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observation. The dam appears to be structurally stable. The apparent materials in the embankment and the relatively flat side slopes should provide adequate safety against shear failures. No indications of seepage through the embankment or along the toe were observed.

Analyses presented in Section 5 indicate that the dam will be overtopped by about 0.9 feet for about 6 hours by one-half the Probable Maximum Flood. It would appear that such overtopping would not seriously affect the structural stability of the dam.

- b. Design and Construction Data. No design or construction data were available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.
- c. Operating Records. There are no controlled operating facilities for this dam.
- d. Post Construction Changes. The inspection team is not aware of any post construction changes for this dam.
- e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of the magnitude predicted in this area is not expected to cause structural failure of this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

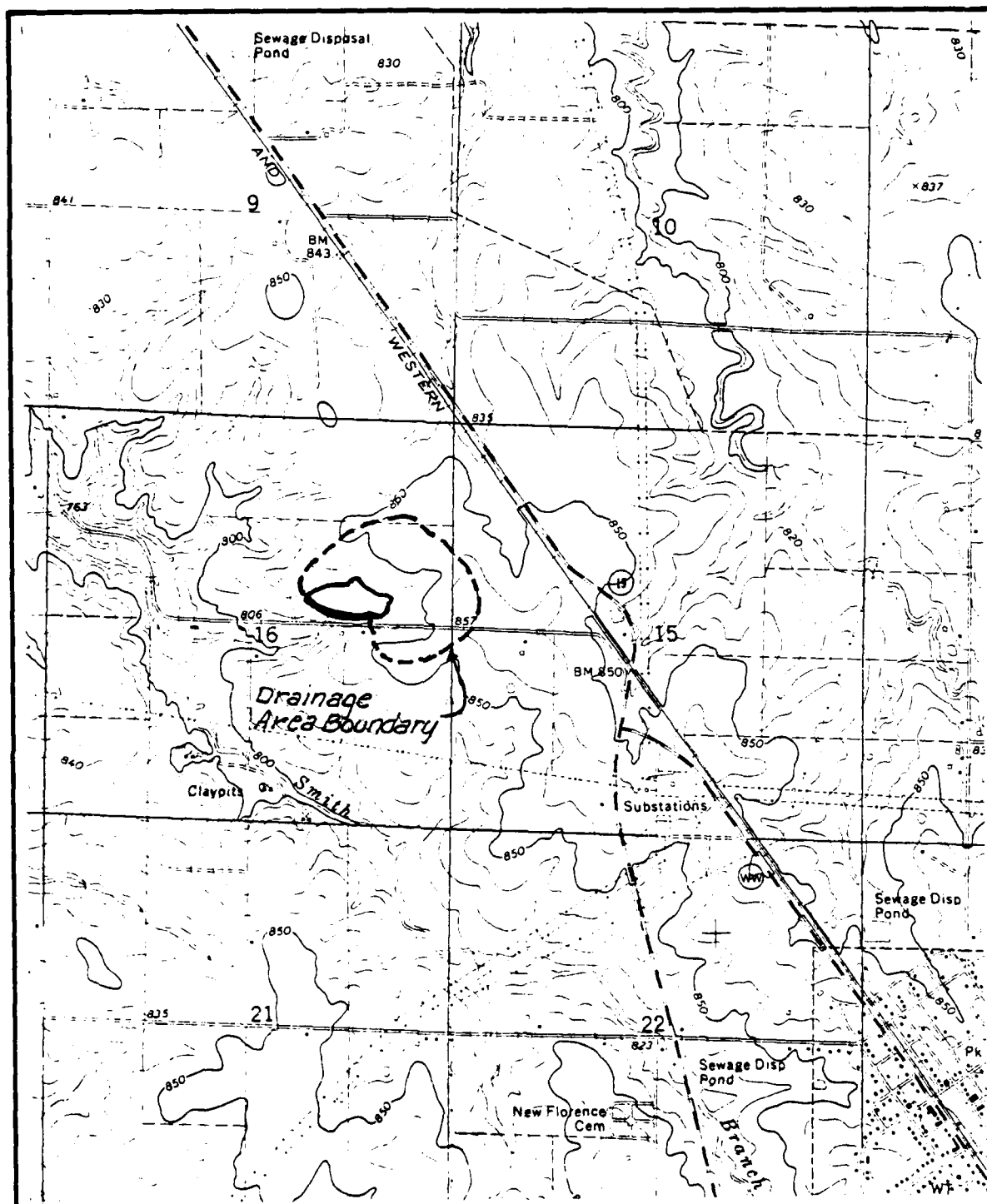
- a. Safety. This structure appears to be in good shape with no serious potential of failure. Additional studies would be required to assess the hazard classification; the potential for overtopping; and the affects of such overtopping on the erosional stability of the dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available which is considered a deficiency.
- b. Adequacy of Information. Due to the lack of engineering data, the conclusions in this report are based upon performance history and visual observations. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available which is considered a deficiency.
- c. Urgency. The item recommended in paragraph 7.2.a. should be pursued on a high priority basis.
- d. Necessity for Phase II. Phase II investigation is not considered necessary.
- e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam.

7.2 REMEDIAL MEASURES

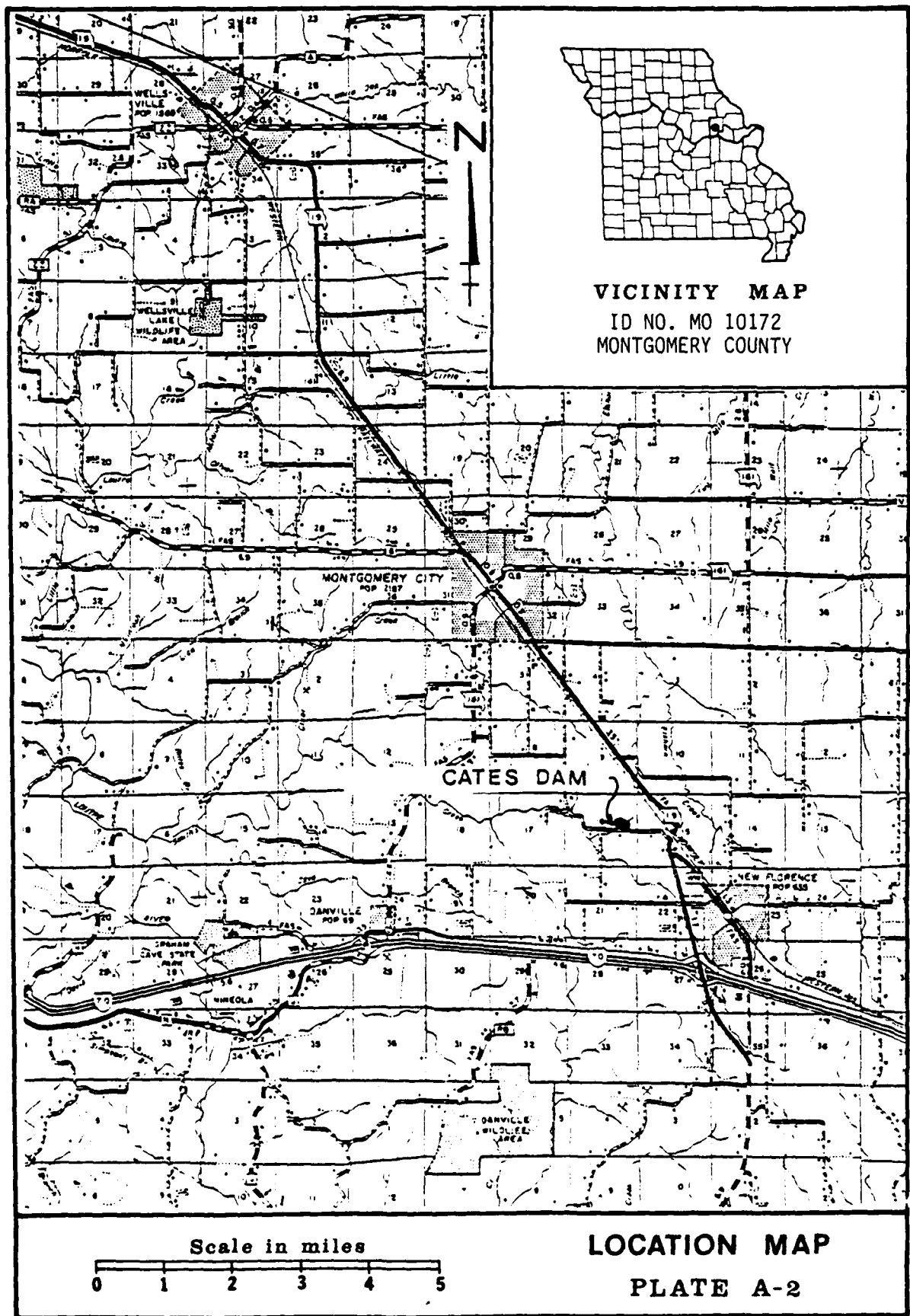
- a. Alternatives. Additional information should be obtained on the potential hazards of failure, and on the topographic characteristics of the reservoir area to determine the increase in the height of dam or the size of the spillway that is necessary to pass one-half the Probable Maximum Flood without overtopping the dam. The services of an engineer experienced in the design and construction of dams should be obtained to evaluate the present reservoir storage capacity, to provide seepage and stability analyses of the present dam, and to design protective measures, if required.
- b. O & M Procedures.
 - (1) Trees should be removed from the upstream face of the dam and from the emergency spillway inlet and outlet channel.

- (2) Minor erosion on the upstream slope should be corrected.
- (3) A program of periodic inspection and maintenance should be initiated to control tree growth and erosion on the embankment and appurtenant channels.

APPENDIX A
MAPS



<p>Scale in feet</p> <p>2000 1000 0 2000 4000</p> <p><i>Contour Interval - 10'</i></p>	<p>N</p> <p>VICINITY TOPOGRAPHY</p> <p>CATES DAM</p> <p>MONTGOMERY COUNTY, MO.</p> <p>MO. 10172</p> <p>PLATE A-1</p>
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APPENDIX B
PHOTOGRAPHS

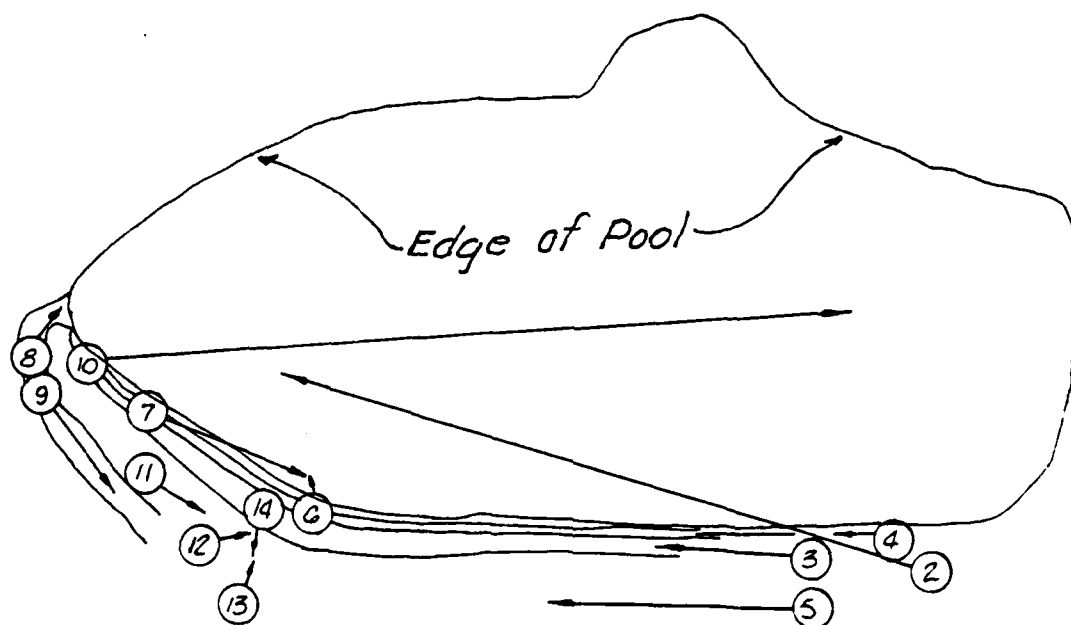


PHOTO INDEX

CATES DAM

MONTGOMERY COUNTY, MISSOURI

MO. 10172

PLATE B-1



PHOTO NO. 2 - OVERVIEW FROM LEFT END



PHOTO NO. 3 - CREST FROM LEFT END



PHOTO NO. 4 - UPSTREAM SLOPE FROM LEFT END



PHOTO NO. 5 - DOWNSTREAM SLOPE FROM LEFT END



PHOTO NO. 6 - PRINCIPAL SPILLWAY INLET. HOODED INLET WITH
ANTI-VORTEX FLAP.



PHOTO NO. 7 - UPSTREAM SLOPE FROM RIGHT ABUTMENT.



PHOTO NO. 8 - LOOKING UPSTREAM IN EMERGENCY SPILLWAY ON RIGHT
END



PHOTO NO. 9 - LOOKING DOWNSTREAM IN EMERGENCY SPILLWAY



PHOTO NO. 10 - UPSTREAM ACROSS LAKE FROM RIGHT END



PHOTO NO. 11 - DOWNSTREAM SLOPE FROM RIGHT END

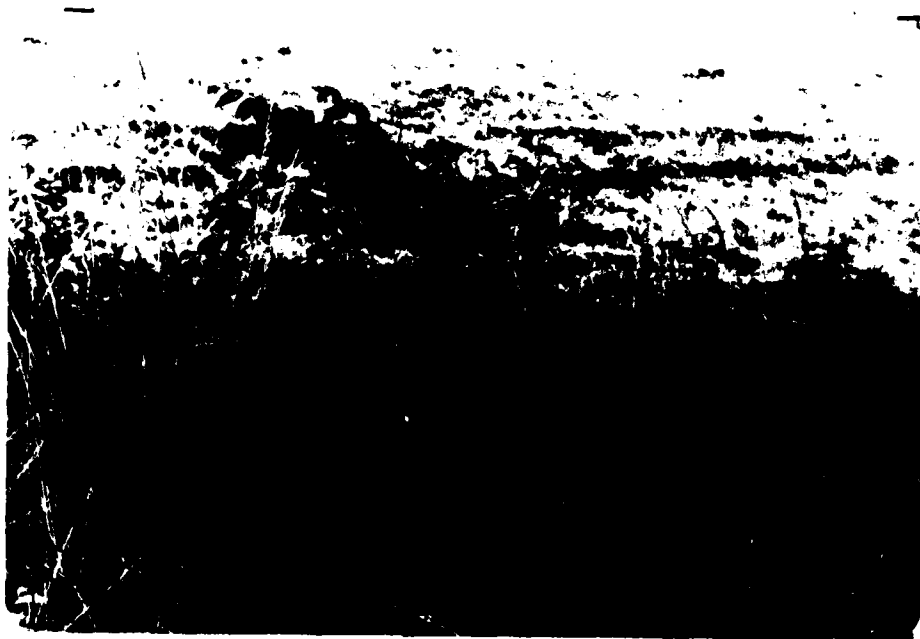


PHOTO NO. 12 - HYDRANT NEAR PRINCIPAL SPILLWAY OUTLET

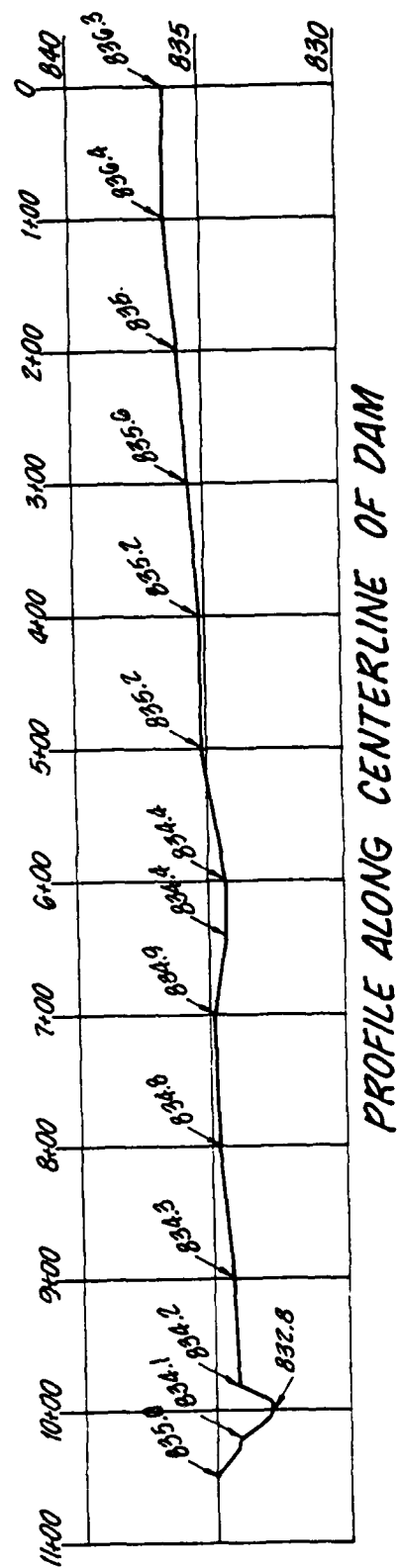
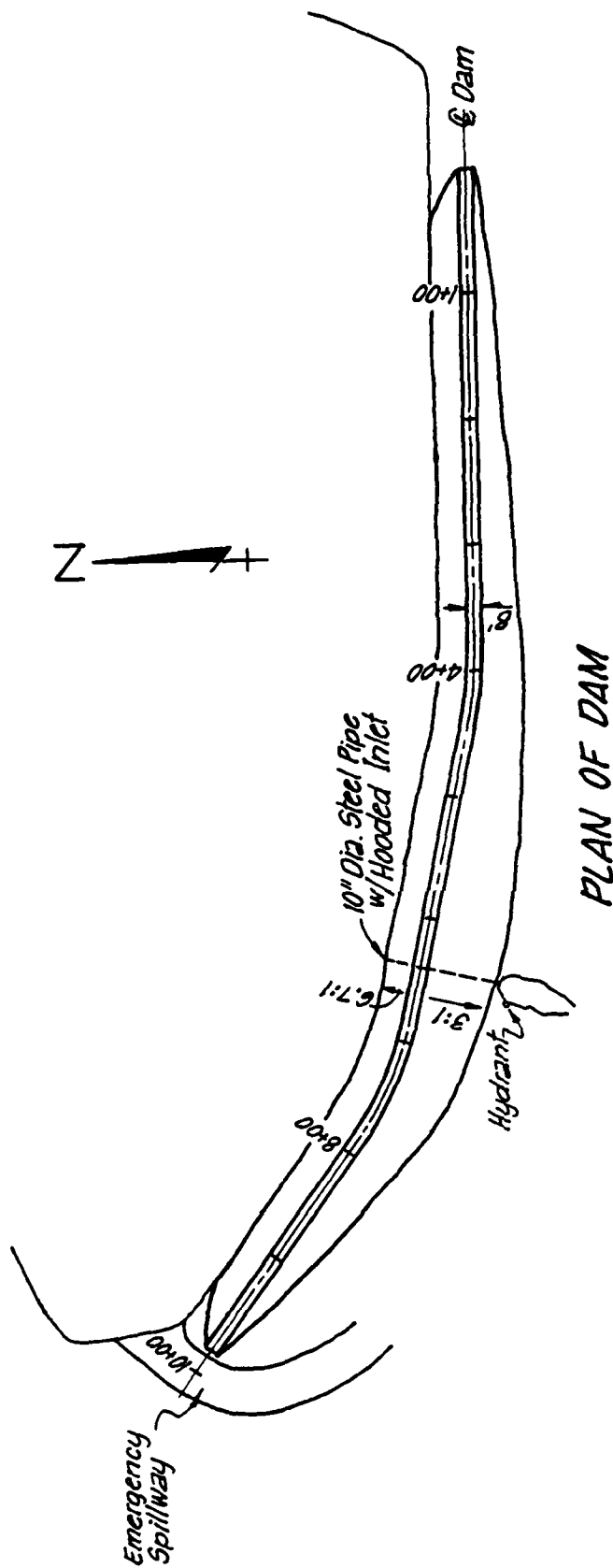


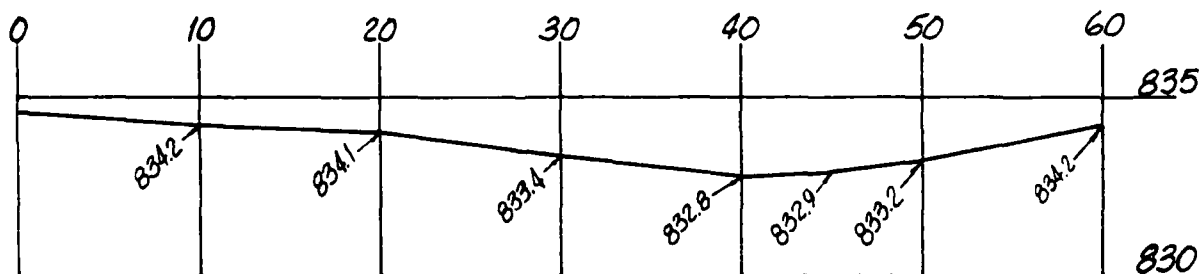
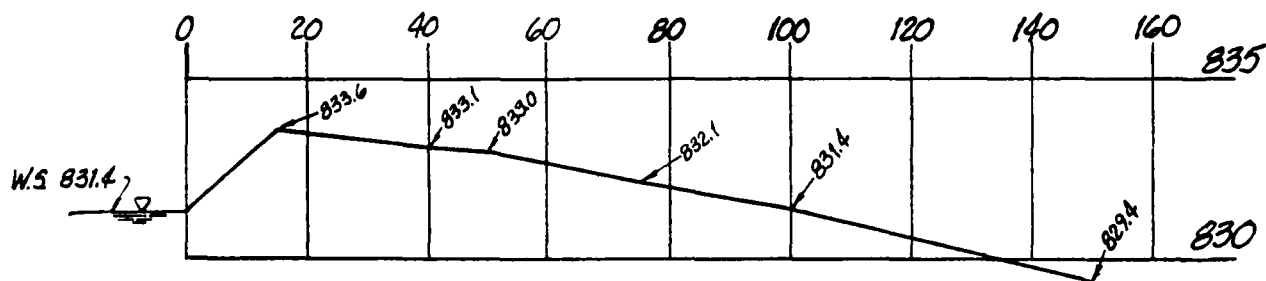
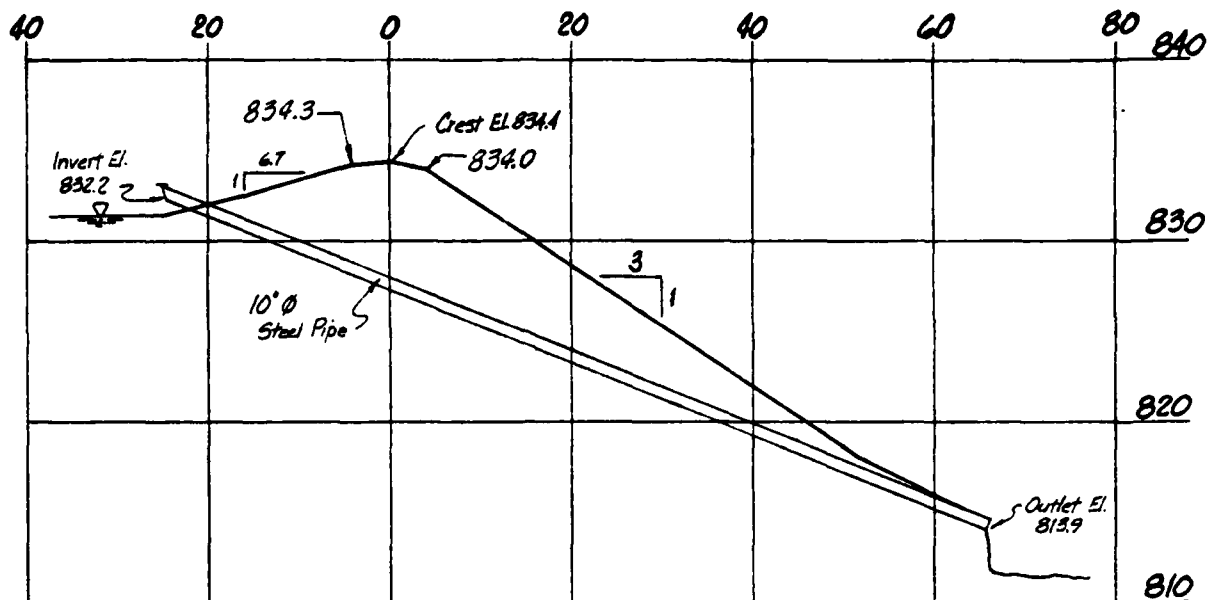
PHOTO NO. 13 - OUTLET
END OF PRINCIPAL SPILLWAY.
ROD DIRECTLY IN FRONT OF
PIPE.



PHOTO NO. 14 - DOWNSTREAM
OUTLET CHANNEL PLUGGED
WITH CONCRETE RUBBLE AND
BRUSH

APPENDIX C
PROJECT PLATES





APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs (see Appendix D).
 - a. Twenty-four hour, 100-year and 10-year rainfall for the dam location were taken from the data for the rainfall station at Sullivan, MO. as supplied by the St. Louis District, Corps of Engineers per their letter dated 6 March 1979. The twenty-four hour probable maximum precipitation was taken from the curves of the Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology.
 - b. Drainage area = 0.12 square miles (77 acres).
 - c. Time of concentration of runoff = 14 minutes (computed from Kirpich formula).
 - d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the 100-year and 10-year precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the invert of the principal spillway.
 - e. The total twenty-four hour storm duration losses for the 100-year storm were 1.53 inches. The total losses for the PMF storm were 0.62 inches. These data are based on SCS runoff curve No. 95 and No. 87 for antecedent moisture conditions SCS AMC III and AMC II respectively. The watershed is composed of soils primarily from the SCS soil group D (Mexico Silt Loam and Mexico Silt Clay Loam). The entire watershed is cropland.
 - f. Average soil loss rates = 0.03 inch per hour approximately. (for PMF storm, AMC III)
2. The combined discharge rating consisted of three components: the flow through the principal spillway, the flow through the emergency spillway and the flow going over the top of the dam.

- a. The principal spillway rating was developed by using the full conduit flow equation:

$$Q = a \sqrt{\frac{2gH}{1 + K_e + K_b + K_p L}}$$

where a = cross-sectional area of pipe, ft² = 0.545

H = total head, ft.

K_e = coefficient for entrance loss = 1.08

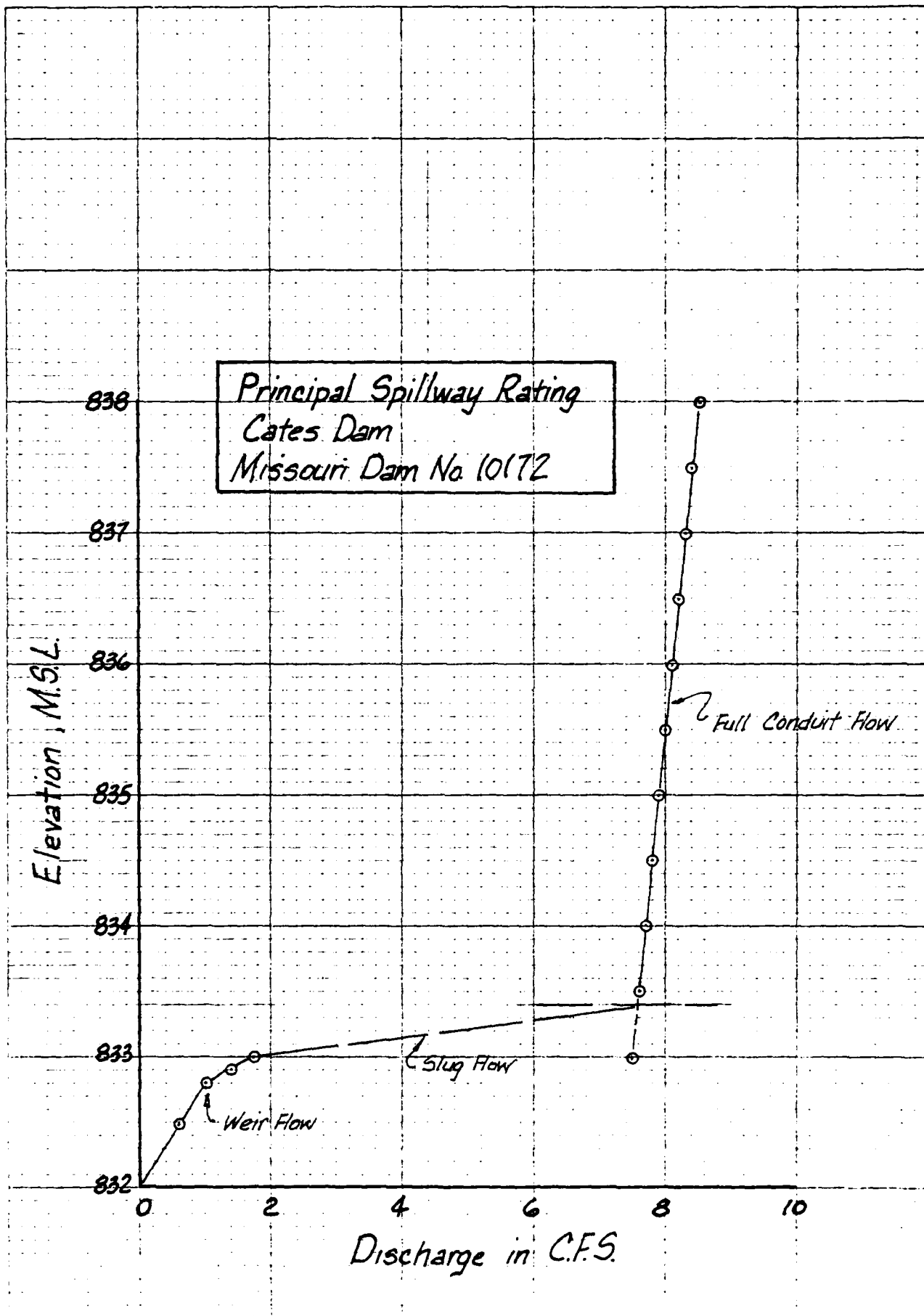
K_b = coefficient for bend loss = 0

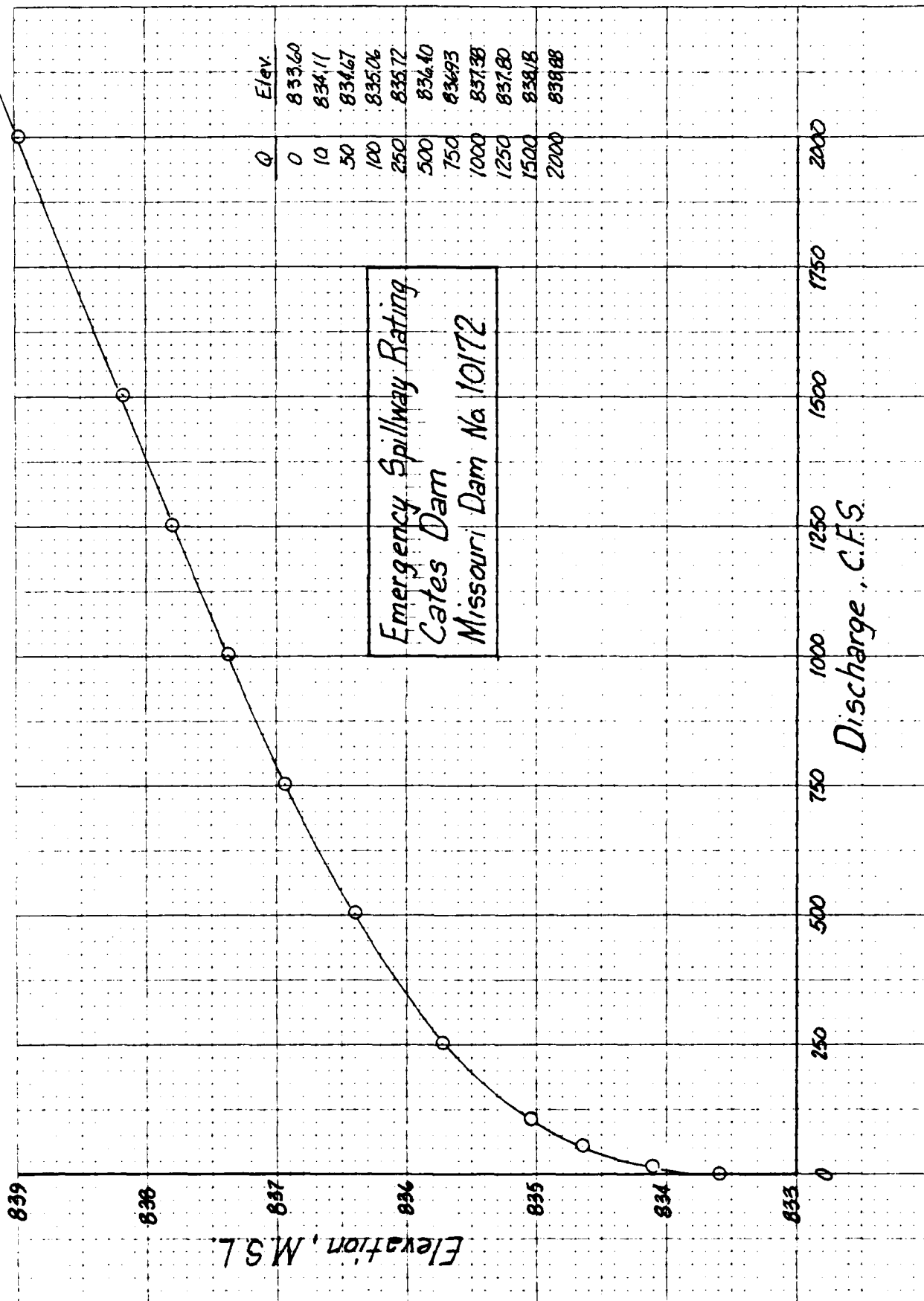
K_p = coefficient for pipe friction loss = 0.0464 (n=0.014)

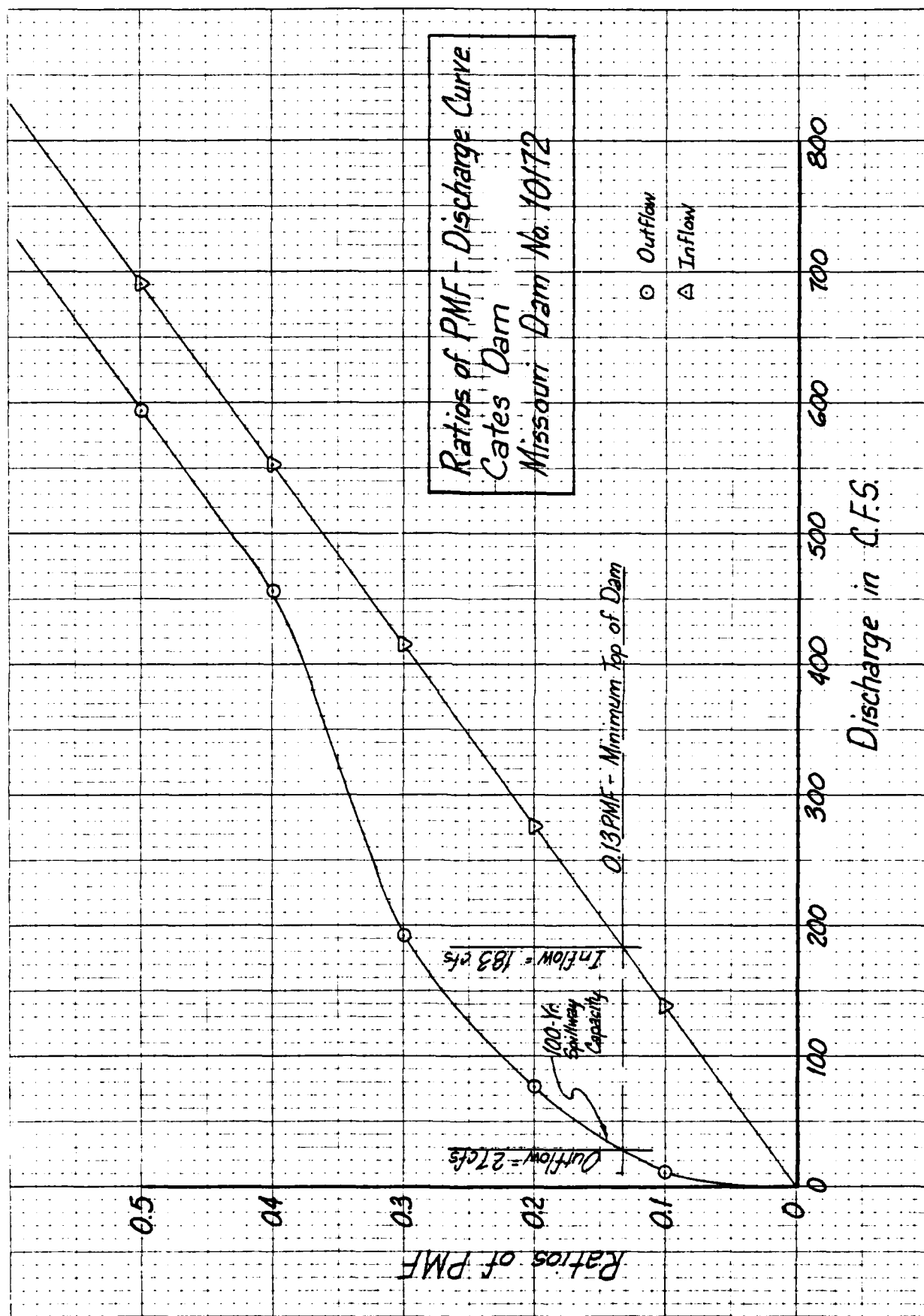
L = length of pipe, ft. = 92

Weir flow for low heads was determined from Table 21.37 "Upstream Head and Discharge Ratios For Pipes Flowing Partly Full" in Handbook of Applied Hydrology, Ven TeChow.

- b. The emergency spillway rating was developed using the Corps of Engineers Surface Water Profile HEC-2 computer program.
- c. The flows over the dam were developed using the dam overtopping analysis (irregular top of dam) within the HEC-1 (Dam Safety Version) program.
3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The output and plotted hydrographs are attached.







CATES DAM

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF			
HYDRAULIC-HYDRAULIC ANALYSIS OF SAFETY OF			
RATIOS OF PMF RATED THRU THE RESERVOIR			
NO.	DATE	NO.	DATE
1	10/17/72	10/17/72	10/17/72
2	10/17/72	10/17/72	10/17/72
3	10/17/72	10/17/72	10/17/72
4	10/17/72	10/17/72	10/17/72
5	10/17/72	10/17/72	10/17/72
6	10/17/72	10/17/72	10/17/72
7	10/17/72	10/17/72	10/17/72
8	10/17/72	10/17/72	10/17/72
9	10/17/72	10/17/72	10/17/72
10	10/17/72	10/17/72	10/17/72
11	10/17/72	10/17/72	10/17/72
12	10/17/72	10/17/72	10/17/72
13	10/17/72	10/17/72	10/17/72
14	10/17/72	10/17/72	10/17/72
15	10/17/72	10/17/72	10/17/72
16	10/17/72	10/17/72	10/17/72
17	10/17/72	10/17/72	10/17/72
18	10/17/72	10/17/72	10/17/72
19	10/17/72	10/17/72	10/17/72
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21	10/17/72	10/17/72	10/17/72
22	10/17/72	10/17/72	10/17/72
23	10/17/72	10/17/72	10/17/72
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29	10/17/72	10/17/72	10/17/72
30	10/17/72	10/17/72	10/17/72
31	10/17/72	10/17/72	10/17/72
32	10/17/72	10/17/72	10/17/72
33	10/17/72	10/17/72	10/17/72
34	10/17/72	10/17/72	10/17/72
35	10/17/72	10/17/72	10/17/72
36	10/17/72	10/17/72	10/17/72
37	10/17/72	10/17/72	10/17/72
38	10/17/72	10/17/72	10/17/72
39	10/17/72	10/17/72	10/17/72
40	10/17/72	10/17/72	10/17/72
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42	10/17/72	10/17/72	10/17/72
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75	10/17/72	10/17/72	10/17/72
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83	10/17/72	10/17/72	10/17/72
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85	10/17/72	10/17/72	10/17/72
86	10/17/72	10/17/72	10/17/72
87	10/17/72	10/17/72	10/17/72
88	10/17/72	10/17/72	10/17/72
89	10/17/72	10/17/72	10/17/72
90	10/17/72	10/17/72	10/17/72
91	10/17/72	10/17/72	10/17/72
92	10/17/72	10/17/72	10/17/72
93	10/17/72	10/17/72	10/17/72
94	10/17/72	10/17/72	10/17/72
95	10/17/72	10/17/72	10/17/72
96	10/17/72	10/17/72	10/17/72
97	10/17/72	10/17/72	10/17/72
98	10/17/72	10/17/72	10/17/72
99	10/17/72	10/17/72	10/17/72
100	10/17/72	10/17/72	10/17/72

 FLUID HYDROGRAPH PACKAGE (HEC-11)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79

RUN DATE= 7/28/72
 TIME= 11.12.27.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
 HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF ~~NO NAME~~ 13-10172 CATES DAM
 RATIOS OF PMF ROUTED THRU THE RESERVOIR

JOB SPECIFICATION											
NO	NIIR	NMIN	IDAY	THR	IMIN	MEHC	IPRT	IPRT	IPRT	IPRT	IPRT
288	0	5	0	0	0	0	0	0	0	0	0
			JOPER	NMT	LROPT	TRACE					
			5	0	0	0					

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 8 LRTIO= 1
 RTIOS= .10 .20 .30 .40 .50 .65 .80 1.00

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDROGRAPH TO 10172 RESERVOIR

ISTAQ	ICOMP	TECON	ITYPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000001	0	0	0	2	0	1	0	0

HYDROGRAPH DATA											
HYDRO	ISNG	ISNG	SNAP	TRSDA	TRSPC	RATIO	ISNGW	ISAME	LOCAL		
1	2	.12	0.00	.12	1.00	0.000	0	1	1	3	

PRECIP DATA			
SPFE	PMS	R6	R24
0.00	24.8	102.50	130.00

LOSS DATA											
LPDPT	STKR	DLIKR	MTUL	ERAIN	STKRS	RTIOK	SIRTL	CNSTL	ALSMX	RTIMP	
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-95.00	0.00	0.00	

CURVE NO = -95.00 WETNESS = -1.00 EFFECT CN = 95.00

UNIT HYDROGRAPH DATA
 TC= 0.00 LAG= .17

RECESSION DATA
 SIRTL= 0.00 GRCSN= -.01 RTIOL= 1.00

UNIT HYDROGRAPH 12 END OF PERIOD ORDINATES, TC= 0.00 WETNESS, LAG= .17 VOL= 1.00
 81. 252. 297. 162. 81. 44. 23. 12. 6. 3.

END-OF-PERIOD FLOW

	PEAK DPT.	6-HOUR 21.0	24-HOUR 20.52	72-HOUR 20.52	TOTAL 19056.
CS	25.	6.	2.	66.	540.
INCHES		413.24	521.14	521.14	521.14
AC-FT		104.	131.	131.	162.
THOUS CU YD		128.	162.	162.	162.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	104.	298.	81.	81.	23,554.
CMS	31.	7.	2.	2.	664.
INCHES		20.02	25.25	25.25	29.25
AC-FT		508.60	641.40	641.40	641.40
THOUS CU M		1.28	1.62	1.62	1.62
		1.58	1.99	1.99	1.99

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1380.	223.	102.	102.	29310.
CMS	39.	9.	3.	3.	810.
INCHES		25.03	31.56	31.56	
MM		635.75	801.75	801.75	801.75
AC-FT		2.60	202.	202.	202.
THOUS CU M		1.97	249.	249.	249.

ROUTED FLOWS THRU 10172 RESERVOIR

ISTAQ	IECON	ITYPE	JPLT	JPRI	INAME	ISTAGE	IAUTO
000002	1	0	2	0	1	0	0
ROUTING DATA							
GROSS	AVG	IRIS	ISAME	IUPI	IPMP	LSTR	
0.00	0.000	1	1	0	0	0	
NSIPS	NSTDL	LAG	AMSKK	X	STORA	ISPRAT	
1	0	0	0.000	0.000	-832	-1	

PLATE D-8

PLATE D-10

[illegible]

PIAK WIFLOW IS 593. AT TIME 15.83 HOURS

THOUS CU M

STAT1UN000002

[illegible]

4.45 571
 4.50 581
 4.55 591
 5.00 601
 5.05 611
 5.10 621
 5.15 631
 5.20 641
 5.25 651
 5.30 661
 5.35 671
 5.40 681
 5.45 691
 5.50 701
 5.55 711
 6.00 721
 6.05 7301
 6.10 7401
 6.15 750
 6.20 760
 6.25 770
 6.30 780
 6.35 790
 6.40 800
 6.45 810
 6.50 820
 6.55 830
 7.00 840
 7.05 850
 7.10 860
 7.15 870
 7.20 880
 7.25 890
 7.30 900
 7.35 910
 7.40 920
 7.45 930
 7.50 940
 7.55 950
 8.00 960
 8.05 970
 8.10 980
 8.15 990
 8.20 1000
 8.25 1010
 8.30 1020
 8.35 1030
 8.40 1040
 8.45 1050
 8.50 1060
 8.55 1070
 9.00 1080
 9.05 1090
 9.10 1100
 9.15 1110
 9.20 1120
 9.25 1130
 9.30 1140
 9.35 1150
 9.40 1160
 9.45 1170
 9.50 1180

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PLAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO	RATIOS APPLIED TO FLOWS							
					1	2	3	4	5	6	7	8
					.10	.20	.30	.40	.50	.65	.80	1.00
HYDROGRAPH AT	000001	.12	1	138.	276.	414.	552.	690.	828.	966.	1104.	1380.
	(	.31)	(	3.91)	7.82	11.73	15.63	19.54	23.45	27.36	31.26	39.08
ROUTED TO	000002	.12	1	11.	76.	291.	456.	593.	730.	867.	992.	1272.
	(	.31)	(	.32)	2.15	8.24	12.90	16.79	20.68	24.57	28.46	36.02

PLAY !

הקצוץ נכנס למיקסר ומוערב היטב.